Siro Kurita & Makoto Nishida*: **Cytotaxonomy of Japanese *Sphenomeris*****

栗田 子郎・西田 誠*: 日本産ホラシノブ属の細胞分類学**

(Pl. I～III)

The genus *Sphenomeris* Maxon contains about 20 species which are distributed in pantropic regions, south to New Zealand and Madagascar, and north to Japan and Florida. In Japan, there have been two species of the genus, namely *Sphenomeris biflora* (Kaulf.) Tagawa and *S. chusana* (L.) Copel. The former is more or less a rare member in the southern coast vegetations and somewhat succulent, while the latter is one of the most common species in the fern flora of southern Japan.

Recently cytological studies of the genus, including only one species from some localities, have been carried out by Manton and Sledge (1954) and by Mehra and Khanna (1959). In the present investigation, we observed two Japanese species, whose very young fertile fronds were fixed in ordinary recipe of acetic-alcohol for about 24 hours. The observation was carried out through Manton's (1950) aceto-carmine squash method.

Observations

1) *S. biflora* (Kaulf.) Tagawa

We obtained the materials at Koishikawa Botanical Garden of the University of Tokyo, which were collected at Tauji, Izu, Shizuoka Pref. and cultivated in the greenhouse. This species has 8 spore mother cells in each sporangium which yields 32 normal spores with bilateral symmetry. We found 48 bivalent chromosomes at the first meiotic metaphase as shown in Pl. I, Figs. 1 and 2. Late zygotene of the first meiotic division of this species is shown in Pl. II, Fig. 3. The pairing phenomenon and many chromomeres are observed conspicuously at this stage.

2) *S. chusana* (L.) Copel.

The wild specimens from Hamaoka and Kikugawa, Shizuoka Pref. are examined. This species has also 8 spore mother cells which give rise to 32 bilateral spores in each sporangium. At the first meiotic metaphase, shown in Pl. III, Figs. 4 and 5, 94 bivalents were recognized.

---

* Botanical Institute, Chiba University, Yayoi-cho, Chiba, Japan. 千葉大学留学生課程生物学教室.

** Contributions from the Laboratory of Phylogenetic Botany, Chiba University. No. 12. 系統植物学研究室業績 No. 12.

Discussion

There are two important problems concerning cytotaxonomy of this genus. The first is the basic chromosome number of the genus. Manton and Sledge (1954) and Manton (1954) reported chromosome number of *S. chusana* Maxon from Ceylon and Malaya, and revealed that the specimen from Ceylon had ca 100 chromosomes in *n* phase, while the specimen from Malaya had approximately 147 bivalents, and sexual reproductions of both plants are normally carried out. Mehra and Khanna (1959) observed the same species from Darjeeling and they found that the specimen performed normal sexual reproduction and had 94 bivalent chromosomes. From these observations, Mehra and Khanna (1959) concluded that the genus *Sphenomeris* had both basic numbers of 47 and 50, and the Malayan materials which had ca 147 bivalents were a compound hexaploid induced by hybridization between what had the basic number of 47 and what had 50. On the other hand we found the number 48 in *S. biflora.* It seems, therefore, to exist three basic numbers, 47, 48 and 50. Meanwhile the reproduction of *S. biflora* is carried out apogamously. This fact is very interesting, for monoploid apogamous ferns are quite unknown by this time. If the number 48 is exactly a basic chromosome number, this is a new type of apogamous ferns. Another interpretation, however, would be requested for the solution of apogamy of the Japanese *Sphenomeris.* Japanese species *S. bifora* may not be a haploid

Tab. 1. Chromosome numbers of the genus *Sphenomeris* Maxon.

Species	Chromosome number	Reproduction	Locality	Investigator
S. chinensis Maxon	n=94	sexual	Darjeeling, India	Mehra and Khanna (1959)
S. chusana (L.) Copel.	n=ca 100	——	Ceylon	Manton and Sledge (1954)
——	n=ca 147	——	Malaya	Manton (1954)
——	'n'=94	Apogamy ?	Japan	Kurita and Nishida
S. biflora (Kaulf.) Tagawa	'n'=48	Apogamy	——	——

one but an apomitic diploid whose basic number is 24, because it is generally believed that the haplont is not favourable to survive apogamous reproduction. But we would not like to conclude whether chromosome number of 48 in Japanese *S. biflora* is diploid or haploid. Further studies will be required.

The second point of discussions is the problems of phyletic relationships to other genera. According to their external morphology, Copeland (1947) maintained "The affinity of *Sphenomeris* is to *Odontosoria*, in relation to which it may be ancestral or approximately so; and to *Lindsaea* which is probably a cognate genus but possibly parental". Now the cytology of *Sphenomeris* revealed the existence of three basic chromosome numbers, 47, 48 or 24 and 50. On the other hand *Lindsaea* have four basic chromosome numbers, 34, 41, 47 and 50 (Manton and Sledge 1954, Brownlie 1957, and Manton 1958). As for the *Odontosoria*, however, we have no cytological data by this time. Therefore we can only compare cytologically *Sphenomeris* with *Lindsaea*. Mehra and Khanna (1959) concluded that both genera might have close relation to each other, as they had the same basic numbers, 47 and 50. Our opinion agree with their considerations and we believe that the presence of the number 48 in the *Sphenomeris* never compels to revise above consideration. Because the number 48 in *S. biflora* seems to be induced by reduction from 50 as seen in *S. chinensis*, and the former, hence, would become apogamous inspite of its haploid phase. The number 47 seems also to be induced from 48 or 50. But 47 soon doubled to 94 as seen in *S. chusana* in which normal sexual reproduction is sometimes revived (in the specimen from Darjeeling).

Some authors identified *S. biflora* as *S. chusana* or treated the former as a variant of the latter (Copeland 1958, H. Ito 1944). But both species ought to apparently be distinguished from each other on the view-points of their cytology. Copeland (1958) and Ching (1959) identified *S. chinensis* as *S. chusana*. But so-called *S. chinensis* seems to consist of several races, one of which would be identified as *S. chusana*.

Summary

Two Japanese species of the genus *Sphenomeris* Maxon were cytologically investigated. Chromosome counts are listed in Table 1. The discovery of apogamous reproduction in *S. biflora* is very interesting. This species may be a

haploid race and has 48 chromosomes. This suggests the presence of apogamy in monoploid ferns instead of polyploid ones, unless it is interpreted that its basic number is 24. As for the affinity of *Sphenomeris*, we support the considerations of Copeland (1947) and of Mehra and Khanna (1959).

References

1*) Brownlie, G., 1957. New Phytol., **56**: 207–209. 2) Ching, R.C., 1959. Flora Republicae popularis sinicae Vol. 2. Peking. 3) Copeland, E.B., 1947. Genera filicum. Chron. Bot. Publ. Walth. Mass. 4) ———, 1958. Fern flora of the Philippines Vol. 1. Manila. 5) Ito, H., 1944. Icones filicum japonicum. Tokyo (in Japanese). 6) Manton, I., 1950. Problems of cytology and evolution in the Pteridophyta. Cambridge, University Press. 7) ———, 1954. Cytological notes on one hundred species of Malayan ferns, in Holttum's Flora of Malaya. 623–627. 8) ———, 1958. Journ. Linn. Soc. London, **56**: 73–92. 9) ———, and Sledge, W.A., 1954. Phil. Tr. R. Soc. London, **238**: 127–185. 10) Mehra, P.N., 1961. Resear. Bull. Panjab Univ. (N.S.), **12**, Parts I–II: 139–164. 11) ———, and Khanna, K.R., 1959. Jour. Genetics, **56**: 1–14.

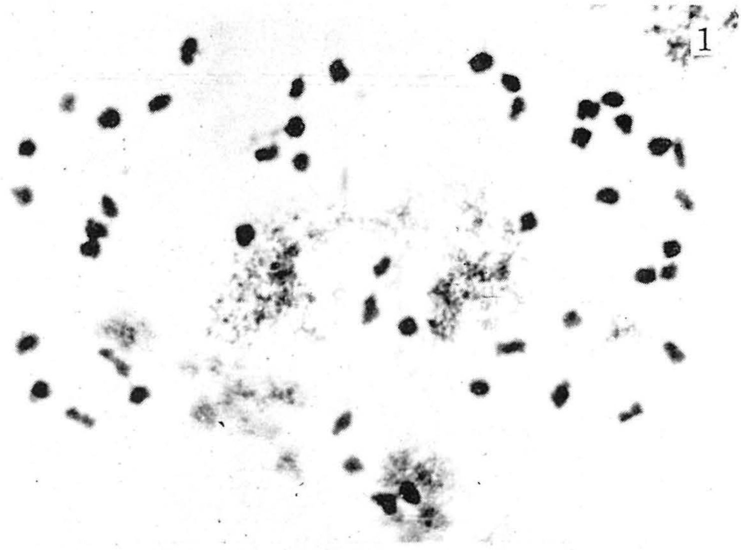
* Not studied in original.

* * * * *

ホラシノブとハマホラシノブの染色体数を観察した。胞子母細胞の第1減数分裂中期においてホラシノブでは94の2価染色体が，ハマホラシノブでは48の2価染色体がみられた。すでにManton and Sledge (1954)はCeylon産のホラシノブでn=ca 100を，Malaya産のものでn=ca 147を報告している。またMehra and Khanna (1959)はHimalaya産のものでn=94を観察しホラシノブ属の基本染色体数は47, 50で，系統的には47の基本染色体数を一部に持つホングウシダ属に最も近いものであると論じている。この論議に対し異存はない。

一方ハマホラシノブが48の染色体数を持つことが知られたのでこの属には47, 48の2つの基本数があることになる。しかしこの研究で使用したハマホラシノブは明らかにアポガミーをなすものであるから基本数は24であるかも知れない。でなければ‘n’=48のハマホラシノブはシダ類ではじめて自然状態において発見された半数性でアポガマスな種である。

ハマホラシノブはホラシノブと同一種，あるいはホラシノブの変種として取扱われることがあるが，染色体数の面から考えると別種として取扱った方が良いと思う。



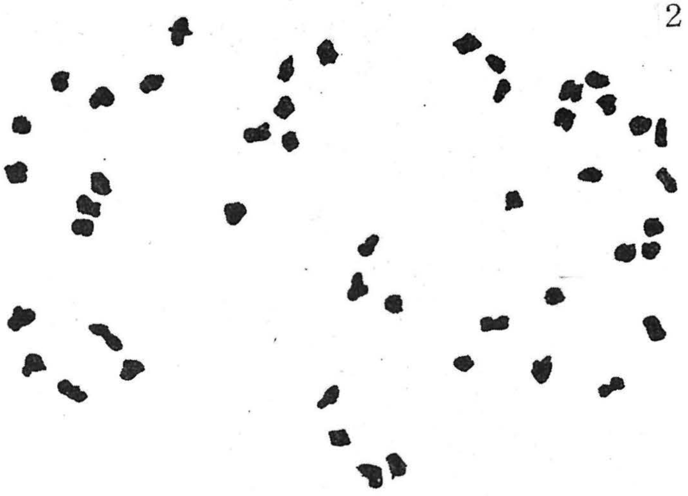


Fig. 1. The first meiotic metaphase of *S. biflora*, showing 48 bivalent chromosomes.
Fig. 2. Explanatory diagram of Fig. 1.

S. Kurita & M. Nishida: Cytotaxonomy of *Sphenomeris*

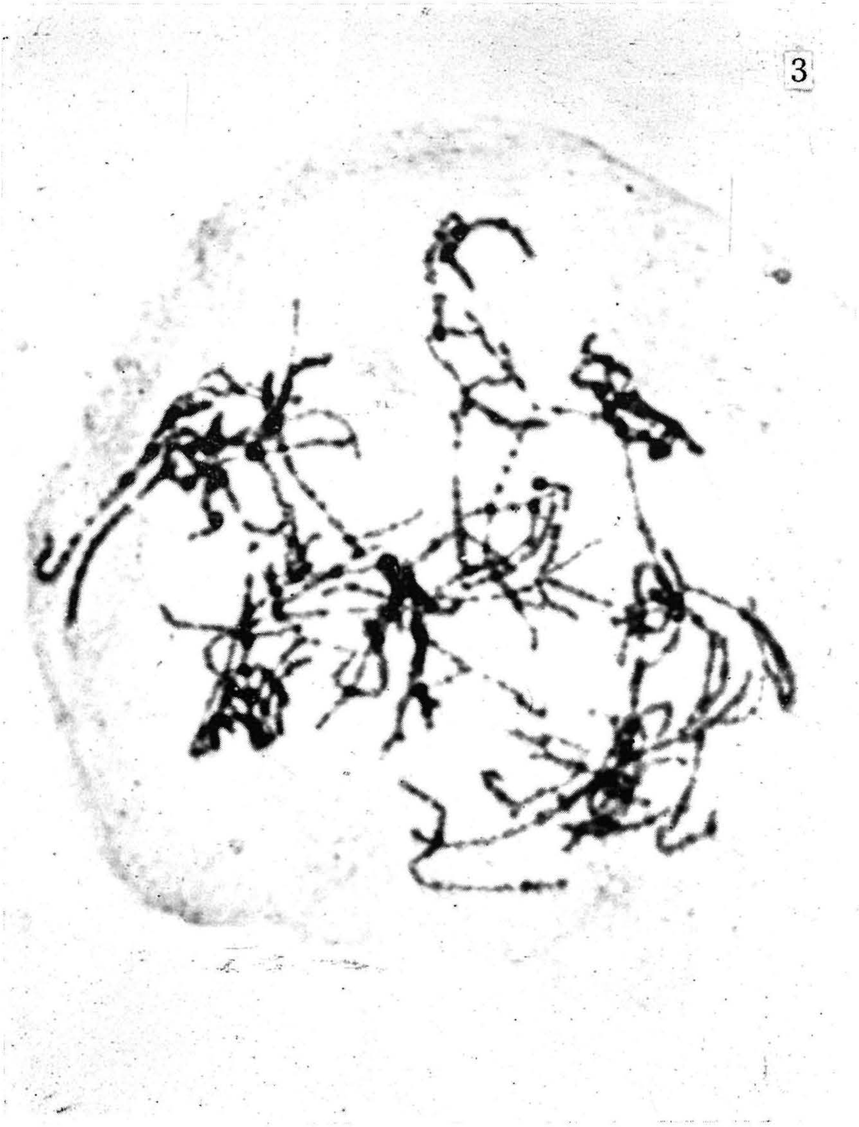
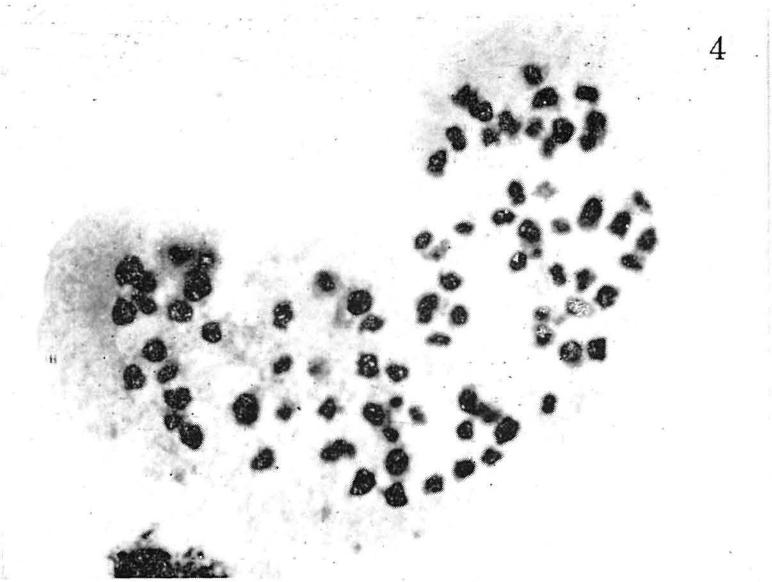


Fig. 3. Late zygotene of the first meiotic division of *S. biflora*.

S. KURITA & M. NISHIDA: Cytotaxonomy of *Sphenomeris*



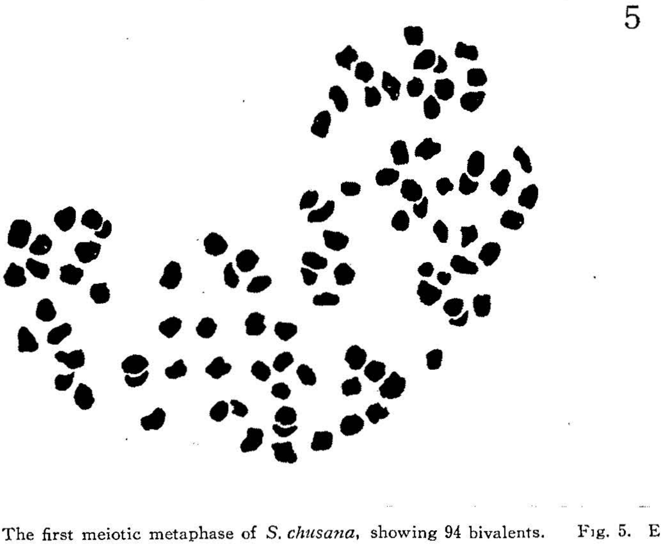


Fig. 4. The first meiotic metaphase of *S. chusana*, showing 94 bivalents. Fig. 5. Explanatory diagram of Fig. 4.

S. KURITA & M. NISHIDA: Cytotaxonomy of *Sphenomeris*